Chapter 2

1995 USGS National Oil and Gas Play-Based Assessment of the South Florida Basin, Florida Peninsula Province

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Volume Title Page

By Richard M. Pollastro

National Assessment of Oil and Gas Project:

Petroleum Systems and Assessment of the South Florida Basin

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Overview

The Florida Peninsula, USGS Province 50, as defined by the 1995 USGS National Oil and Gas Assessment (Gautier and others, 1995), includes all of the State of Florida east of the Apalachicola River and the adjoining State waters; the part of the Florida panhandle west of the Apalachicola River is part of Province 49 (fig. 1). The boundary in the panhandle between Province 50 and Province 49 is a generally north-south-trending line between the counties of Gadsden, Liberty, and Franklin to the east and the counties of Jackson, Calhoun, and Gulf to the west. Province 50, inclusive of State waters, is approximately 150 mi wide and about 400 mi long totaling about 60,000 mi^2. It is bounded to the north by the State boundary with Georgia and to the east, south, and southwest by the boundaries of Florida State waters. The State water boundaries extend to 10.36 statute miles on the Gulf of Mexico side of Florida and to 3 miles on the Atlantic Ocean side (the Gulf-Atlantic boundary line extends westward from the Marquesas Keys along lat 24°35′N., and then turns southward, just west of the Dry Tortugas, along the 83rd west meridian) (fig. 1).

Six conventional hydrocarbon plays were delineated in the South Florida Basin of Province 50 (fig. 2) for the purposes of the 1995 USGS National Oil and Gas Assessment (Gautier and others, 1995; Pollastro and Viger, 1998). The Upper Sunniland Tidal Shoal Oil play (5001) and the Lower Sunniland Fractured "Dark Carbonate" Oil play (5002) are confirmed plays. At the time of the 1995 National Oil and Gas Assessment, about 103 million barrels of oil (MMBO) had been produced from these known plays.

The remaining four plays in the 1995 assessment are hypothetical. They are the Dollar Bay Shoal-Reef Dolomite Oil play (5003), the Lower Cretaceous Carbonate Composite Oil play (5004), the Extended Upper Sunniland Tidal Shoal Oil play (5005), and the Wood River Dolomite Deep Gas play (5006). The easternmost portion of the Smackover Alabama/Florida Updip Oil play (4911) also extends into the Florida Peninsula Province but has been assigned to the Louisiana-Mississippi Salt Basins Province 49; therefore, this play is not shown or defined in this report.

About 370 MMB of undiscovered oil were estimated in the assessment using a play-based methodology from the five plays of the South Florida Basin; an additional 57.5 billion cubic feet of gas (BCFG) or 10 million barrels of oil equivalent (MMBOE) were estimated as gas in oil fields (table 1). Most of the 370 MMBO was from the Lower Cretaceous Sunniland Formation with the two Upper Sunniland Tidal Shoal Oil plays (5001, 5005) estimated to contain 281 million barrels of undiscovered oil.

In 2000, the South Florida Basin was again assessed using the total-petroleum-system method, an approach to assessment of undiscovered oil and gas outlined in detail by the U.S. Geological Survey World Energy Assessment Team (2000). In the total-petroleum-system method, the assessment unit (a subset of the total petroleum system) is used rather than the play as the basic unit to assess the volume of undiscovered oil and gas. The results of the 2000 USGS assessment of the South Florida Basin using the total petroleum system are described in an accompanying report on this CD-ROM.

Hydrocarbon Play Descriptions

Play 5001—Upper Sunniland Tidal Shoal Oil Play

Known only in the subsurface, the Lower Cretaceous Sunniland Formation is the basal unit of the Ocean Reef Group (fig. 2). Onshore, the formation is relatively uniform in thickness and consists of limestone, dolomite, and anhydrite. The upper part of the Sunniland Formation produces heavy, marginally mature varieties of crude oil onshore from porous bioclastic debris mounds, banks, and pods on the eastern margin of the South Florida Basin. The region of productive reservoir facies of the upper Sunniland Formation is defined in part by eight fields that have either produced more than one million barrels of oil (MMBO), or have estimated ultimate recoveries

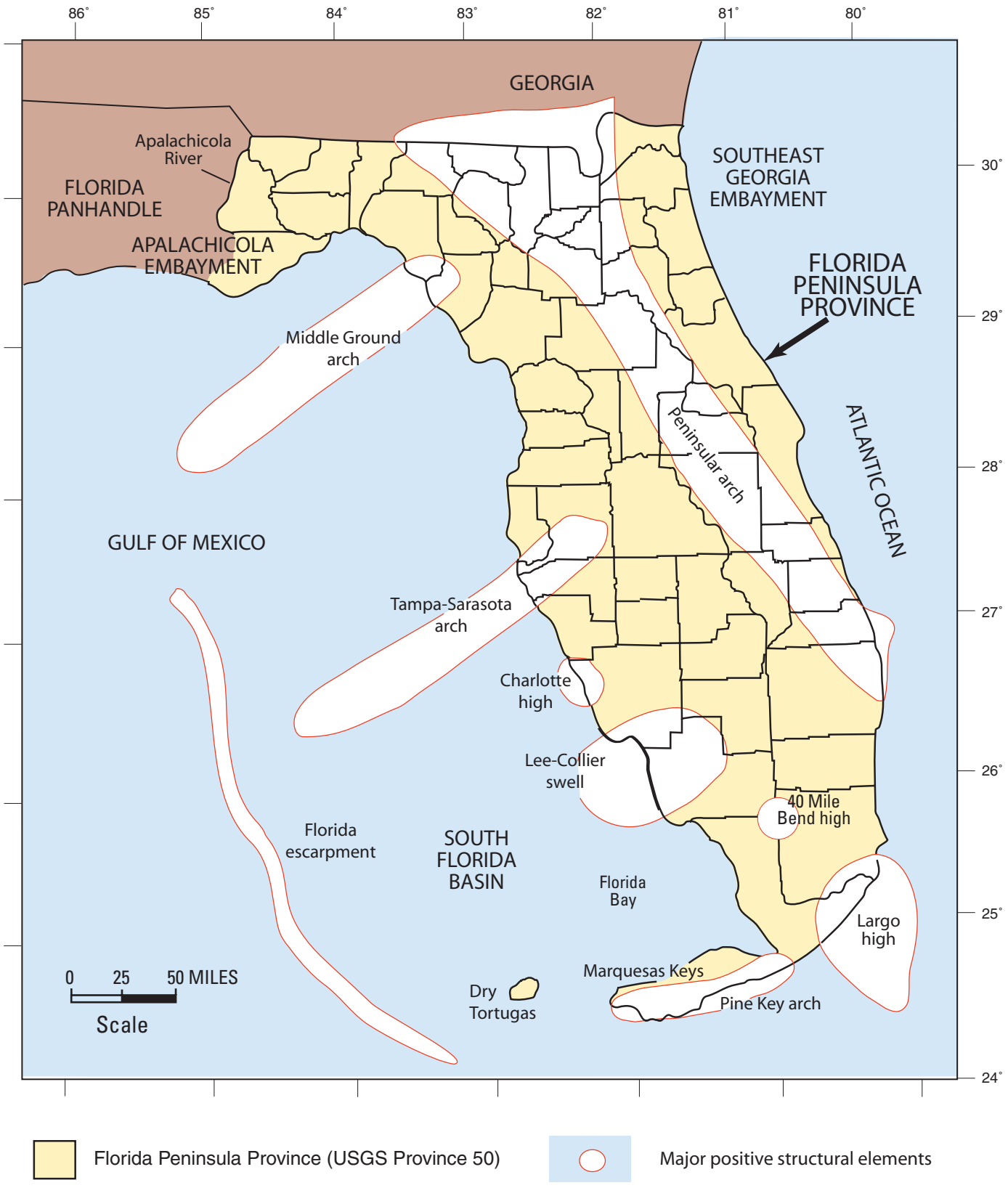

Figure 1. Map showing Florida Peninsula Province (USGS Province 50) and major positive structural elements of the South Florida Basin.

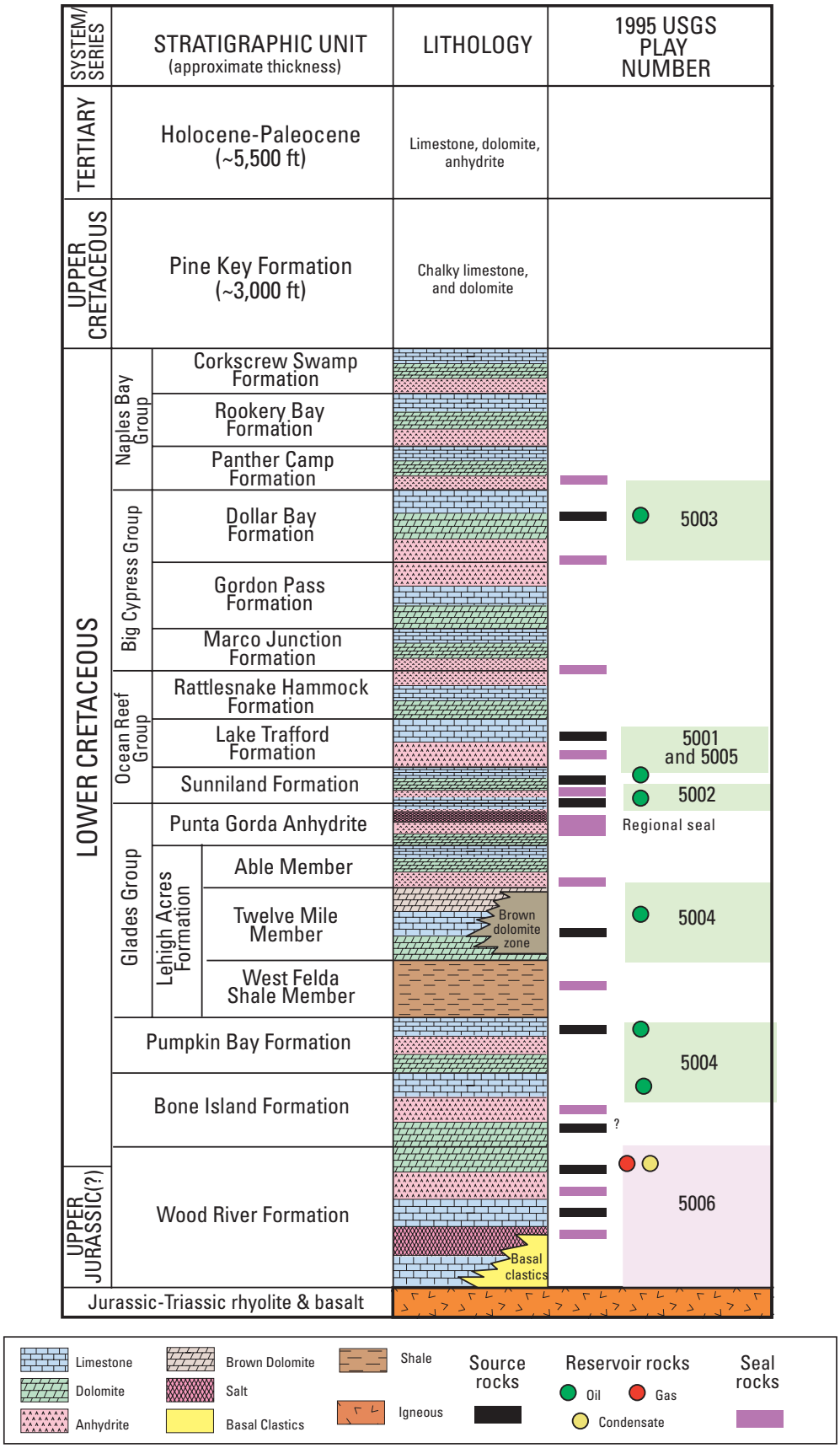

Figure 2. Stratigraphic section of South Florida Basin along Sunniland trend showing 1995 USGS plays. Modified from Faulkner and Applegate (1986).

Table 1. Summary of results of 1995 National Oil and Gas Assessment of undiscovered oil and gas by play, Florida Peninsula Province.

[Play 5006 was highly risked and, thus, not assessed. MMBO, million barrels of oil; BCFG, billion cubic feet of gas]

Size of undiscovered accumulations (MMBO)

Play number	5001	5002	5003	5004	5005
Median	15	2	10	2	4
F_5 largest	110	8	65	20	25
Mean	***22.4***	***2.5***	***13.9***	***3.1***	***6.6***

Number of undiscovered accumulations

Play number	5001	5002	5003	5004	5005
Minimum	2	1	1	1	1
Median	8	4	8	8	6
Maximum	30	20	40	20	30
Mean	***11.3***	***4.8***	***4.8***	***3.4***	***4.9***

Estimate of undiscovered oil in oil fields (MMBO)

Play number	5001	5002	5003	5004	5005	TOTAL
F_{95}	20.6	0	0	0	0	
F_{50}	172.8	6.9	0	0	0	
F_5	594.9	42.8	387.5	50.3	129.7	
Mean	***253.7***	***12.2***	***66.2***	***10.7***	***27.3***	***370.1***

Estimate of undiscovered gas in oil fields (BCFG)

Play number	5001	5002	5003	5004	5005	TOTAL
F_{95}	1.73	0	0	0	0	
F_{50}	14.52	0.58	0	0	0	
F_5	61.87	3.60	31.00	25.15	11.02	
Mean	***21.30***	***1.00***	***5.30***	***15.30***	***14.59***	***57.5***

(EUR) of at least 1 MMBO, and five additional smaller fields. When combined, these fields form an arcuate northwest-southeast trend, the "Sunniland trend," which is about 20 mi wide and 150 mi long (fig. 3). Generally, the updip limit of the Sunniland is about 50 to 60 miles northeast of the producing trend. The first upper Sunniland Formation oil field discovery was the Sunniland field in 1943; the largest oil field is the West Felda, discovered in 1966, with total production (through July 1993) of more than 44 MMBO. Cumulative production for all upper Sunniland Formation reservoirs through July 1993 was about 103 MMBO.

The northern and updip play boundary for the Upper Sunniland Tidal Shoal Oil play (5001) is delineated by an area in which the upper Sunniland Formation consists of only micritic limestone and contains no reservoir mounds within its intertidal lagoonal-mudflat facies. Moreover, the lower part of the Sunniland dark carbonate source rock is absent. The downdip southern boundary of the play is delineated by an area where wells penetrate an anhydrite-cemented, nonporous sabkha-like facies (fig. 3).

The reservoir facies in the upper Sunniland Formation consist of isolated fossil-shell hash (skeletal grainstones) that may represent storm deposition as shoals in a regionally restricted, back-reef lagoonal area in the warm, shallow marine-shelf setting of the eastern South Florida Basin during the late Early Cretaceous (Mitchell-Tapping, 1987). These tidal shoals were deposited on subtle bathymetric highs that were probably related to underlying basement structure. Later, the upper portions of these porous shoal mounds were subaerially exposed, leached, and dolomitized during a low sea-level stand, further enhancing the reservoir quality of the upper porous zones. Individual debris mounds are about 40 to 100 ft thick (Means, 1977; Montgomery, 1987). Depth to the upper Sunniland Formation tidal shoal reservoir rocks in the producing trend is about 11,200 to 11,600 ft. Most mounds are sealed by overlying impermeable lagoonal mudstones and wackestones, some of which have been dolomitized. Porosities of primary (interparticle) and secondary (dissolution and dolomitization) origin range from 10 to 25 percent and average 15 to 18 percent (Mitchell-Tapping, 1987). Impermeable micritic carbonate and nodular anhydrite beds within the upper Sunniland Formation enclose and seal many of the individual porous reservoir mounds. Moreover, the entire Sunniland Formation is sealed above and below by thick anhydrite units (fig. 2). Most hydrocarbon traps are stratigraphic; however, some mixed stratigraphic/structural traps are present.

The different types of crude oils produced from the grainstone units of the upper Sunniland Formation are immature, having API gravities that range from about 21° to 28° and average 25°–26°; the average gas-oil ratio (GOR) is about 85:1 (Palacas and others, 1984; Tootle, 1991). The source rocks are a dark, micritic carbonate unit (informally referred to as the "dark carbonate" interval) in the lower part of the Sunniland Formation. These micritic carbonates are commonly algal laminated and have total organic carbon (TOC) ranging from less than 0.4 to 3.0 weight percent. Potential source rocks (as identified by more than 0.4 weight percent TOC) average 1.8 weight percent TOC. More than 80 percent of the organic matter in these source rocks is composed of algal-amorphous (oil-prone) kerogen (Palacas, 1984; Palacas and others, 1984). The hydrocarbon-generating potential of the lower Sunniland dark carbonate facies ranges from poor in wells located updip from the producing trend, to good in wells located just downdip, to excellent near the depocenter of the basin (Applegate and Pontigo, 1984). Onshore, the dark carbonate facies varies in thickness from zero at the updip limit of the Sunniland Formation to more than 150 ft in the producing trend. Oil produced from reservoirs in the Sunniland trend was probably generated downdip where the organic matter in the dark carbonate facies is more abundant and more mature. The petroleum then migrated updip and accumulated in the porous grainstone facies of the upper Sunniland (Palacas and others, 1984).

Exploration and development of the upper Sunniland Formation has been minimal based on the drilling history and well distribution within the play area. The eight oil fields in the upper Sunniland Formation that have produced, or have EUR's, more than 1 MMBO are Bear Island, Corkscrew, West Felda, Lehigh Park, Mid-Felda, Raccoon Point, Sunniland, and Sunoco-Felda. Historical data for these eight accumulations are plotted in figure 4 and figure 5 showing relations among known accumulation size, number of exploratory wells, date of discovery, and cumulative known volume. At least three of these eight fields are located in the Big Cypress Swamp drainage and (or) National Reserve, an area of critical environmental concern (Lloyd, 1992). Sensitive environmental and political issues in south Florida have likely discouraged full resource development; however, the success of wells drilled in the past few decades, indicate that the Upper Sunniland Tidal Shoal Oil play has good potential.

The 1995 USGS Assessment estimated undiscovered oil accumulations in the Upper Sunniland play along the main fairway trend (5001) to be of moderate size, having a median size of 15 MMBO and total undiscovered oil estimated at about 254 million barrels (table 1).

Play 5002—Lower Sunniland Fractured "Dark Carbonate" Oil Play

The existence of the Lower Sunniland Fractured "Dark Carbonate" Oil play is based on the discovery of the Lake Trafford field in Collier County. Lake Trafford field is located immediately southeast of Corkscrew field (fig. 6). The dark carbonate unit of the lower part of the Sunniland Formation is believed to contain the primary source beds for oil produced in the tidal shoal grainstone units of the upper part of the Sunniland Formation (plays 5001 and 5005). Although no minimum size (more than 1 MMBO) oil accumulations were proven, the one discovery well (Mobil Oil Corporation; spudded March 1969) used to define the Lake Trafford field

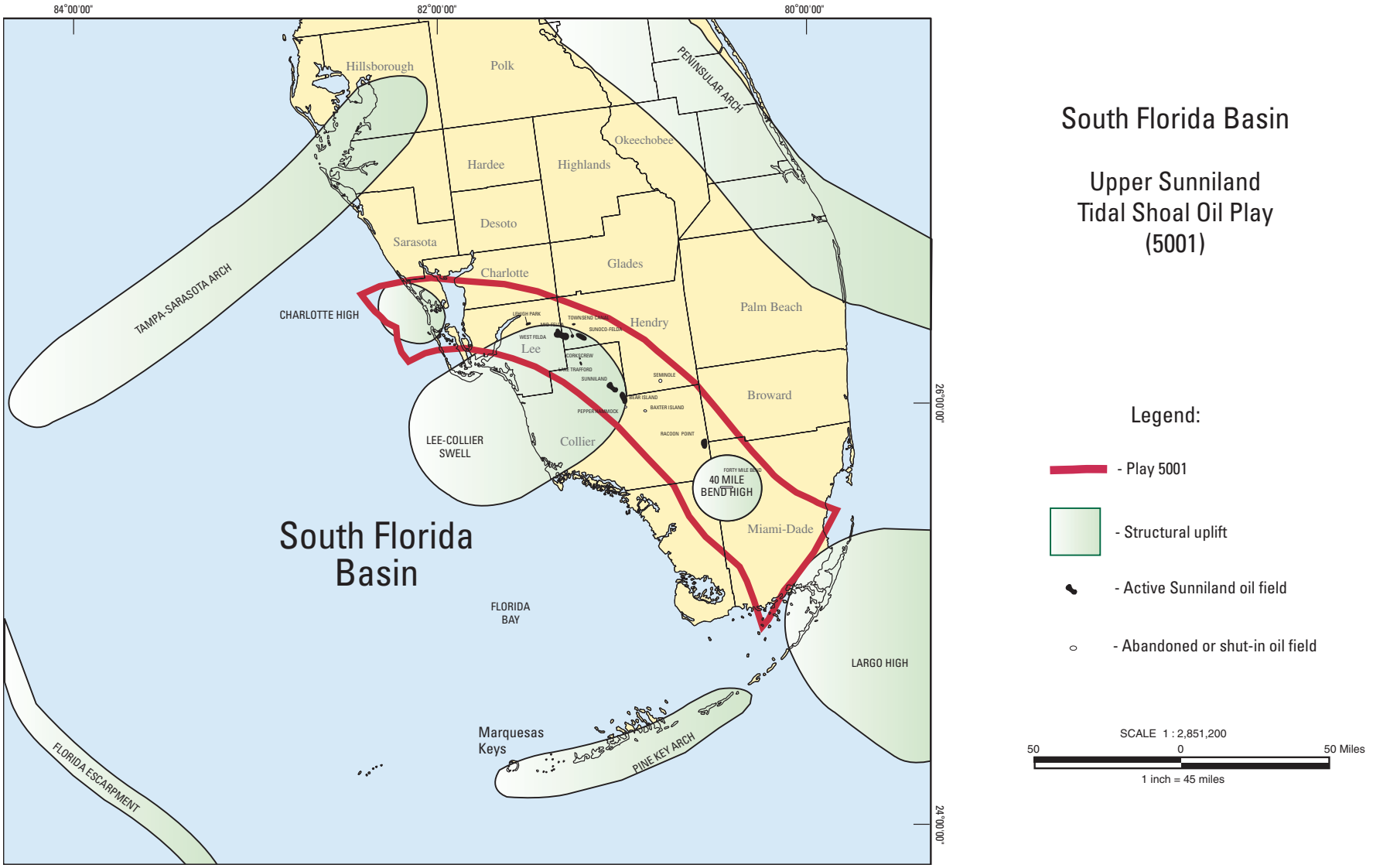

Figure 3. Map of South Florida Basin showing structural uplifts, known oil fields, and boundaries of Upper Sunniland Tidal Shoal Oil play (5001).

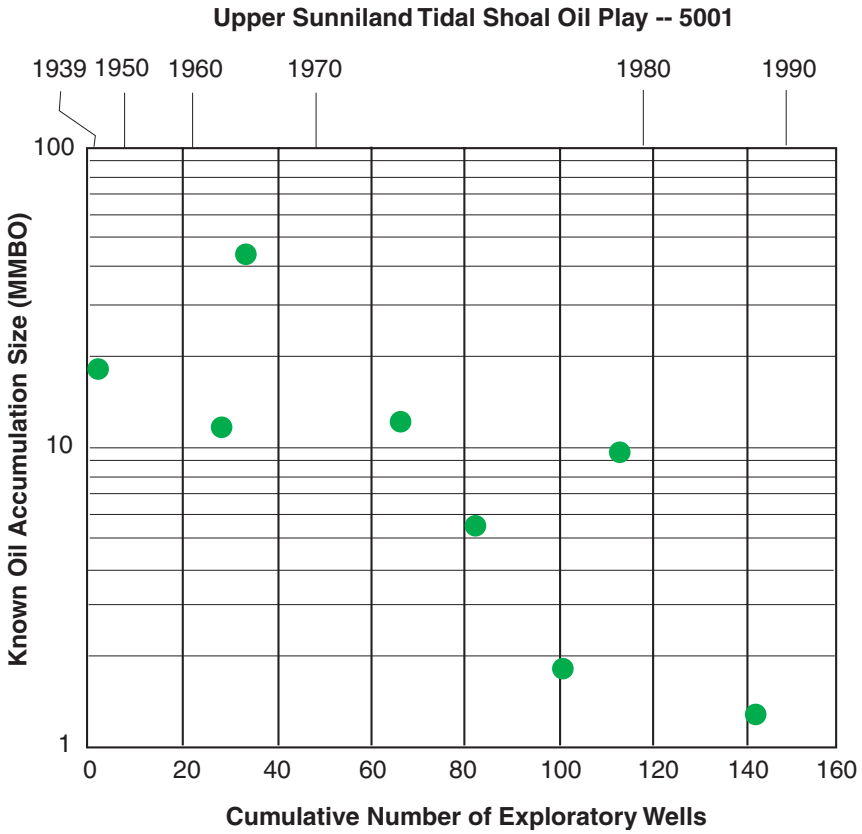

Figure 4. Historical plot for South Florida Basin exploration showing known oil accumulation size (>1 MMBO) versus cumulative number of exploratory wells and discovery year.

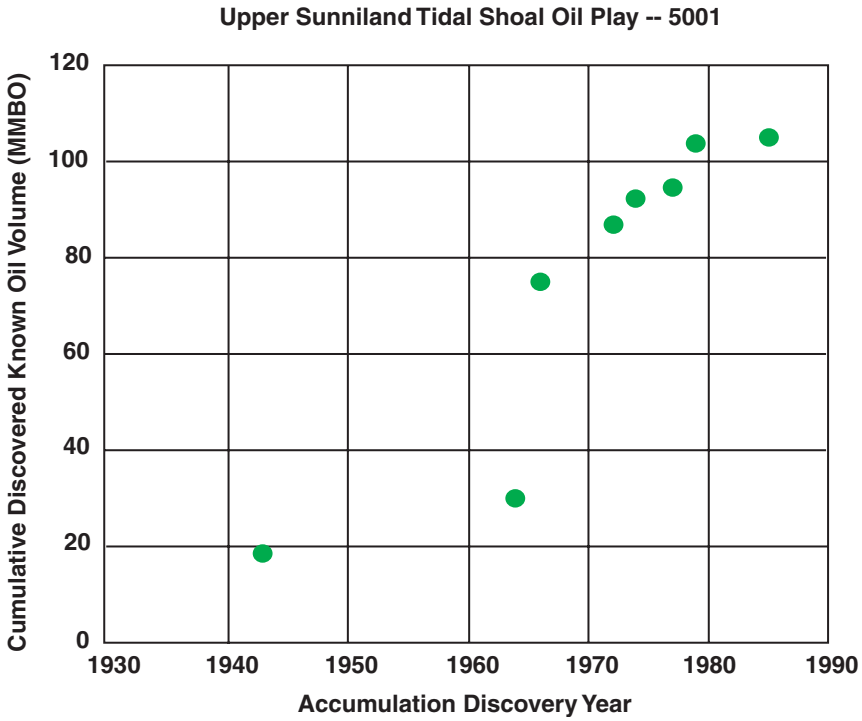

Figure 5. Historical plot for South Florida Basin exploration showing cumulative discovered known oil volume versus discovery year for accumulations >1 MMBO.

produced commercial quantities of oil from fractured limestone at a depth of about 11,800 ft. The producing zone is commonly referred to as the "rubble zone" of the dark carbonate unit in the lower Sunniland Formation (Means, 1977). The matrix porosity of the producing zone, as measured by well logs, is about 9 volume percent, and the pore space is oil saturated. Core recovered from the rubble zone in the discovery well was described as burrowed, fractured, and stylolitized (Lloyd, 1992); these characteristics would increase the porosity and permeability of the rocks, thus increasing the likelihood of commercial production from them. In March 1988, the discovery well was shut in after producing about 278,000 barrels of oil. Two offset vertical wells, located to the northwest and south of the producing well, and a recent horizontal test well were dry holes. Based on the production history of the one vertical well, horizontal wells penetrating the rubble zone of the dark carbonate unit are estimated to produce a few hundred barrels of oil per day. Owner/operator Brian Richter (oral commun., 1994) reported that the horizontal test well missed the targeted pay zone; however, subsequent successful horizontal tests have reopened the field.

The play boundary is defined by two factors: (1) the thickness of the dark carbonate unit, partly determined from the examination of cross sections and observations of structural isopachs (Applegate and Pontigo, 1984), and (2) evidence (in core recoveries from reference wells) (Lloyd, 1992; Mitchell-Tapping, 1984) of the presence of rocks that possess favorable source-rock characteristics and either the presence of the rubble zone or evidence of fracturing (Montgomery, 1987). This play is assigned moderate potential for undiscovered oil resources. The area of the play that has the best potential for undiscovered oil resources is northwest of the Lake Trafford field. Expected depths of production within the play area are estimated between 10,000 and 13,000 ft, with a median depth of about 11,800 ft. Potentially productive fractured reservoir rocks are present in the lower dark carbonate zone of the lower Sunniland Formation and are enclosed by impermeable, micritic, tidal-flat, lime mudstones. The unit is sealed below by the Punta Gorda Anhydrite.

Indigenous hydrocarbons are produced from brown and medium-dark-gray micritic and argillaceous limestones whose total carbonate content average 76 weight percent and range from 50 to 98 weight percent. These micritic carbonates are commonly algal laminated and have TOC values ranging from less than 0.4 to 3.0 weight percent. Potential source beds (more than 0.4 weight percent TOC) within the unit average about 1.8 weight percent TOC. Oil produced from the well in the Lake Trafford field has an API gravity of about 26°, similar to oil in upper Sunniland producing wells (API gravity ranging from 21° to 28°). Inasmuch as oils in the upper Sunniland Formation are derived from source rocks in the lower dark carbonate, the similarity in API gravities is to be expected. Similarly, lower Sunniland oils are expected to have a GOR range similar to that of upper Sunniland oils (about 80:1 to 100:1).

Median size for undiscovered fields of the dark carbonate play was estimated at 2.5 MMBO with a mean total undiscovered oil resource estimated at 12.2 million barrels (table 1).

Play 5003—Dollar Bay Shoal-Reef Dolomite Oil Play

The delineation of the hypothetical Dollar Bay Shoal-Reef Dolomite Oil play (fig. 7) is based on (1) interpretations of well-log data obtained from a series of onshore wells reporting numerous shows (Winston, 1971) and (2) the paleoenvironmental reconstructions of Winston (1971) and Mitchell-Tapping (1990) of the reservoir tidal shoal and patch reef facies; the data of Faulkner and Applegate (1986) were also used to delineate this play.

In the onshore portion of the South Florida Basin, the youngest formation that shows characteristics favorable for petroleum generation and accumulation is the Lower Cretaceous Dollar Bay Formation, the uppermost unit of the Big Cypress Group (fig. 2). The unit lies 1,500 ft or more above the Sunniland Formation and is as much as 620 ft thick in some parts of the basin. Onshore, the unit ranges in thickness from about 475 ft to 550 ft. Many wells penetrating the Dollar Bay Formation in south Florida have reported low-gravity (about 17° API) oil shows or tarry residues in both limestone biohermal deposits and an upper dolomite section; however, there has been no commercial production from this play. Like the Sunniland Formation, the Dollar Bay commonly consists of evaporite-carbonate cycles of anhydrite, dolomite, and limestone. These evaporite-carbonate beds formed during a transgressive-regressive cycle; some thin beds of calcareous shale, salt, and lignite are also present (Applin and Applin, 1965; Mitchell-Tapping, 1990). In certain areas of the basin, however, limestone is the dominant lithology of the formation. Speculative production in the Dollar Bay Formation will be from leached limestone units in the middle part of the formation or from a dolomite section in the upper part of the formation.

Mitchell-Tapping (1990) stated that reservoirs exist in tidal shoal deposits and patch reefs in a tidal flat, lagoonal, restricted-marine setting, and in a subtidal platform, open-marine setting. Potential reservoirs include (1) porous, leached, and dolomitized grainstone units in the upper portions of isolated debris mounds, (2) isolated patch reefs in the middle part of the Dollar Bay Formation, and (3) a porous dolomite unit in the upper part of the formation (Mitchell-Tapping, 1990). These potential reservoirs have measured porosities of about 10–30 percent and permeabilities of about 5–60 millidarcies. Traps are created because these reservoirs are draped with impermeable, micritic, tidal-flat, and in some cases argillaceous lime mudstone units and anhydrite. The formation is underlain by thick, dense nodular and nodular-mosaic anhydrite units of the Gordon Pass Formation.

Oil and tarry residues recorded in wells that penetrate the Dollar Bay Formation are believed to originate within the formation (Palacas, 1978a, 1978b; Winston, 1971). The

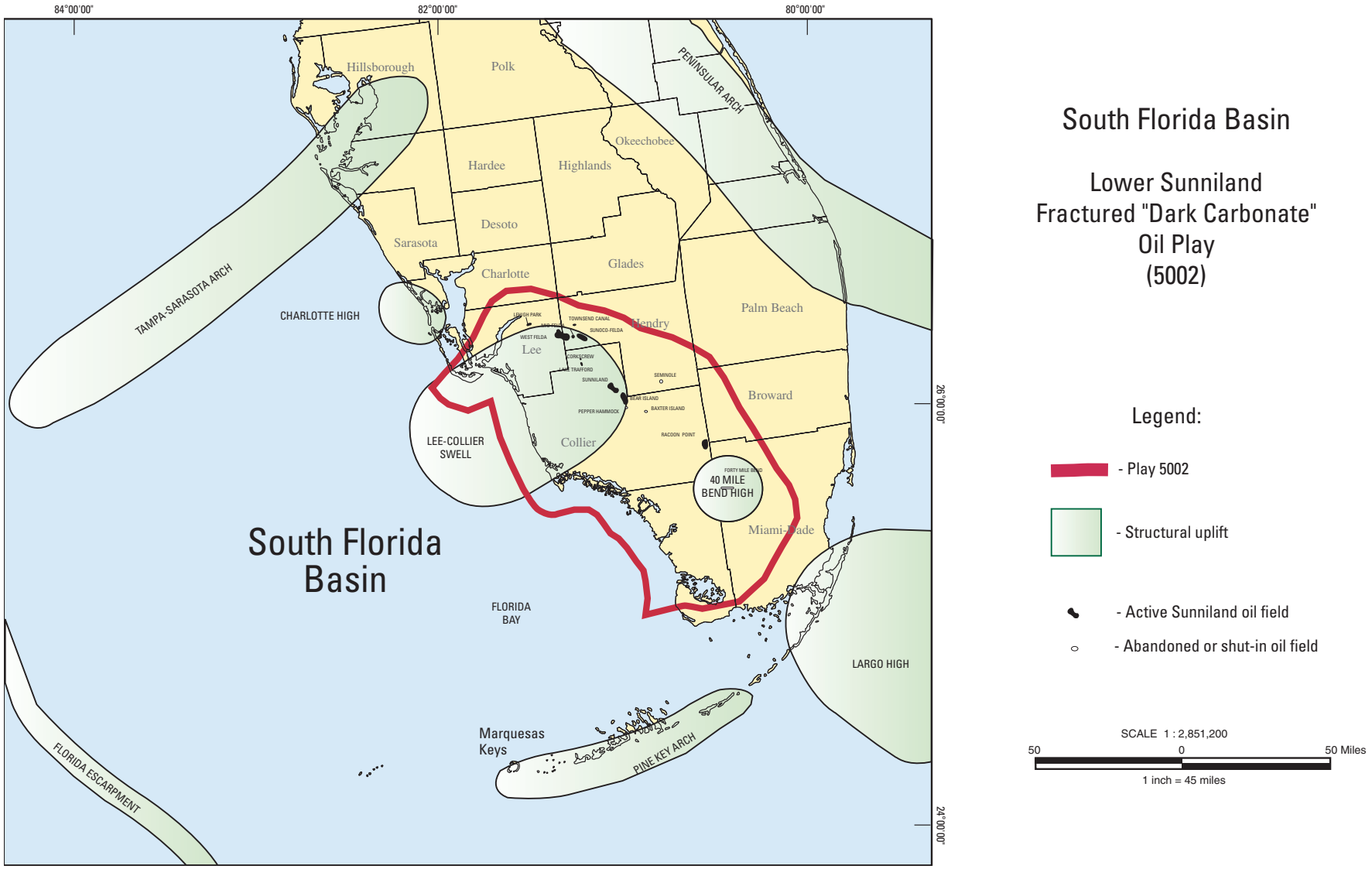

Figure 6. Map of South Florida Basin showing structural uplifts, known Sunniland oil fields, and boundaries of Lower Sunniland Fractured “Dark Carbonate” Shoal Oil play (5002).

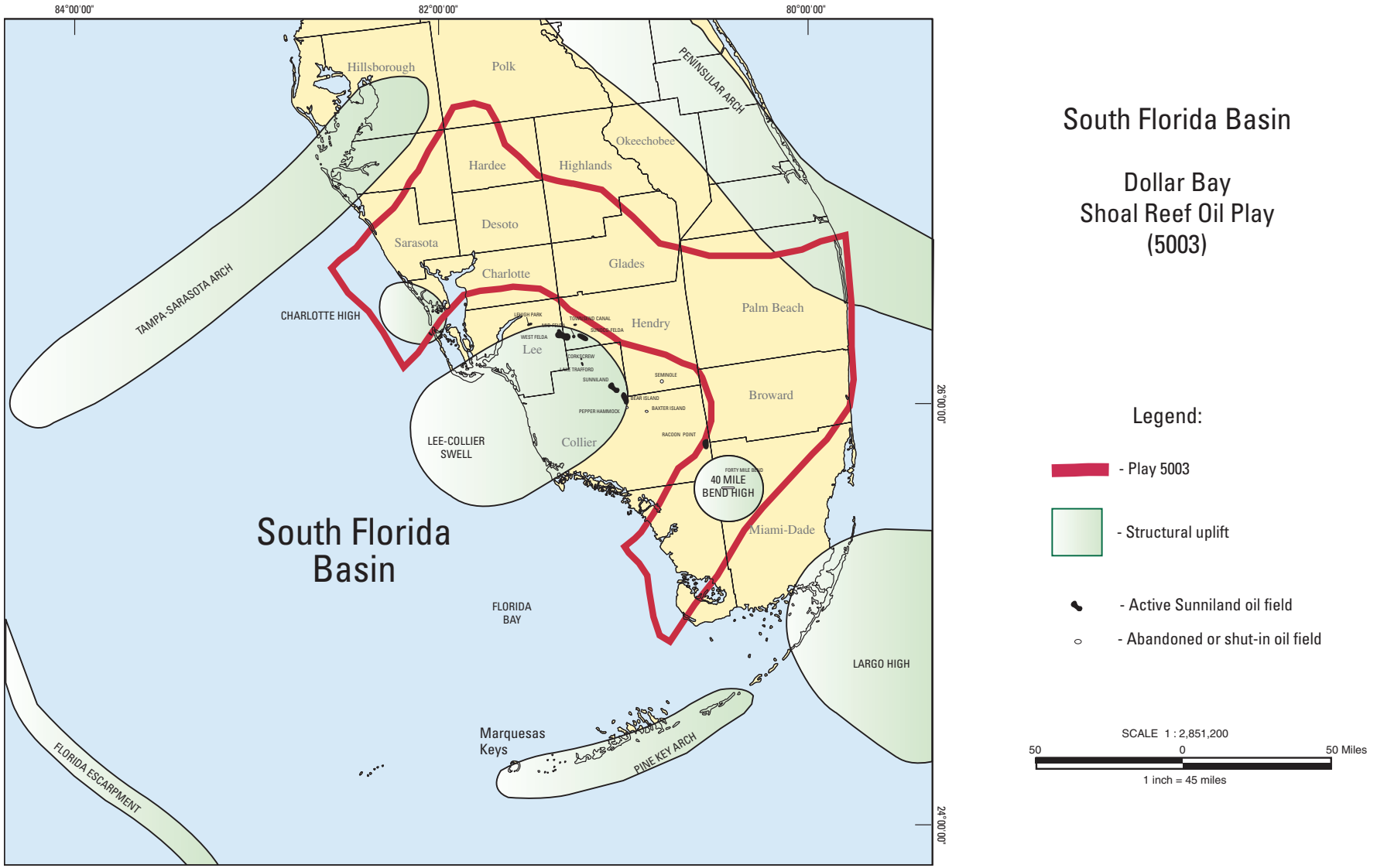

Figure 7. Map of South Florida Basin showing structural uplifts, known Sunniland oil fields, and boundaries of Dollar Bay Shoal Reef Oil play (5003).

organic-matter content of the Dollar Bay Formation ranges from very lean to fairly rich, with some beds containing more than 3 weight percent TOC; the average TOC of the Dollar Bay is about 0.6 weight percent (Palacas, 1978a, 1978b). Most petroleum explorationists infer that rocks of the Dollar Bay Formation located updip and to the northeast of the Sunniland trend are thermally immature and probably have not generated hydrocarbons of commercial quality and quantity (Montgomery, 1987). Others strongly disagree, however, and predict that the Dollar Bay Formation has been overlooked and should be a considered a primary oil target with good resource potential (Winston, 1971; Palacas, 1978a, 1978b; Mitchell-Tapping, 1990).

Offshore, in the more central portion of the basin where the Dollar Bay Formation lies at depths of more than 10,000 ft, the formation rocks should be more thermally mature. Based on one major show that consisted of 15 ft of free oil, API gravity measured 17° at a depth of about 10,000 ft. Thus, API gravities of oil from this play are expected to be low and probably range from 15° to 20° (Mitchell-Tapping, 1990); sulfur contents are similar to those of Sunniland-type oils (2–4 percent). Moreover, the inferred presence of patch reefs and more complex structures in the Federal offshore region, and the increased thermal maturity of rocks of the Dollar Bay Formation in the offshore portion of the basin, enhance the potential for new field discoveries and commercial oil production.

The Dollar Bay Formation was assessed to have the second largest volume of undiscovered oil with a total mean volume of about 66 MMBO. The median number of discoveries was 8 at a median field size of 10 MMBO (table 1).

Play 5004—Lower Cretaceous Carbonate Composite Oil Play

The hypothetical Lower Cretaceous Composite Oil play comprises two units in the South Florida Basin: the Lehigh Acres Formation brown dolomite zone and a potentially porous dolomite unit within the underlying Pumpkin Bay Formation (fig. 2). Both units in this play are believed to contain oil mainly derived from organic-rich beds in the upper part of the Pumpkin Bay Formation.

The play is divided into two separate areas: one is centered in Lee County and intersects the Sunniland trend, and the other is centered near the Marquesas Keys) (fig. 8). The northern part (Lee County and vicinity) includes the area (outlined by Applegate, 1987) containing porous brown dolomite and an area within the Pumpkin Bay Formation that contains live oil in porous dolomite (6–16 percent porosity). The section is thickest (as much as 1,200 ft thick, as measured from reference wells in State waters near Charlotte Harbor and onshore in Collier and Hendry Counties) in these areas and has good to excellent source-rock potential (determined from geochemical and thermal-maturity measurements) (Means, 1977; Applegate and others, 1981; Palacas and others, 1981; Attilio and Blake, 1983; Faulkner and Applegate, 1986; Applegate, 1987; Montgomery, 1987). The rocks of the northern area (fig. 8) possess high porosity caused by epigenetic dolomitization in an active geothermal lineament system (Saul, 1987). Several oil shows were reported in thick, porous dolomite beds in the southern part of the play centered near Marquesas Keys (Faulkner and Applegate, 1986; Lloyd, 1992).

The informally named brown dolomite zone refers to a dolomite unit commonly found within the Twelve Mile Member of the Lower Cretaceous Lehigh Acres Formation (Aptian). The brown dolomite lies about 300 ft below the base of the Punta Gorda Anhydrite and about 1,000 ft below the Sunniland Formation (fig. 2). The unit is best developed onshore in Charlotte County and surrounding counties where it is thickest (about 100 ft) and most porous (10–22 percent) and at a depth of about 12,000 ft (fig. 8). Good oil shows were reported in this unit, and because it is about 1,000 ft lower in the stratigraphic section than the Sunniland Formation, oil from the brown dolomite is predicted to have a higher API gravity (20°–50°?) and higher thermal maturity than oil from the Sunniland Formation.

Reservoirs consist of sucrosic dolomite and exhibit pinpoint to vuggy porosity in beds at least 50 ft below the top of the Twelve Mile Member of the Lehigh Acres Formation. As much as 50 ft of porous dolomite have been found onshore where the brown dolomite zone reaches a maximum thickness of about 100 ft. An onshore area (in Charlotte, Lee, Hendry, Collier, Highlands, and Glades Counties, and adjacent State waters) with the highest resource potential is defined by the porous zones delineated by Applegate (1987). Good oil shows were observed in dolomite penetrated by the Bass Collier 12-2 well in Collier County; porosities determined from a sonic log ranged from 10 to 22 percent and core porosities were as high as 18 volume percent. State and Federal waters are predicted to have high resource potential. In particular, oil stains were noted in about 350 ft of mostly porous dolomite penetrated by wells located near the Marquesas Keys (Faulkner and Applegate, 1986; Lloyd, 1992).

The thickest and deepest sedimentary interval with significant reservoir potential in the South Florida Basin is the Lower Cretaceous Pumpkin Bay Formation. The formation is composed of limestone, except at its northern limit where dolomite is the dominant lithology. Within Province 50, the Pumpkin Bay Formation is as much as 1,200 ft thick in offshore Florida State waters of Charlotte Harbor; the formation is projected to thicken westward in Federal offshore waters and into the basin depocenter (Faulkner and Applegate, 1986). Onshore, the Pumpkin Bay Formation is found at present depths from about 12,500 to 14,000 ft. Core porosities for rocks of the Pumpkin Bay Formation are as high as 20 percent, and sonic well-log porosities are slightly higher. Porosities are generally lower in the Pumpkin Bay Formation than in potential reservoirs found in younger units. Generally, rocks with the highest resource potential in the Pumpkin Bay Formation are located in the Pulley Ridge area of Federal offshore

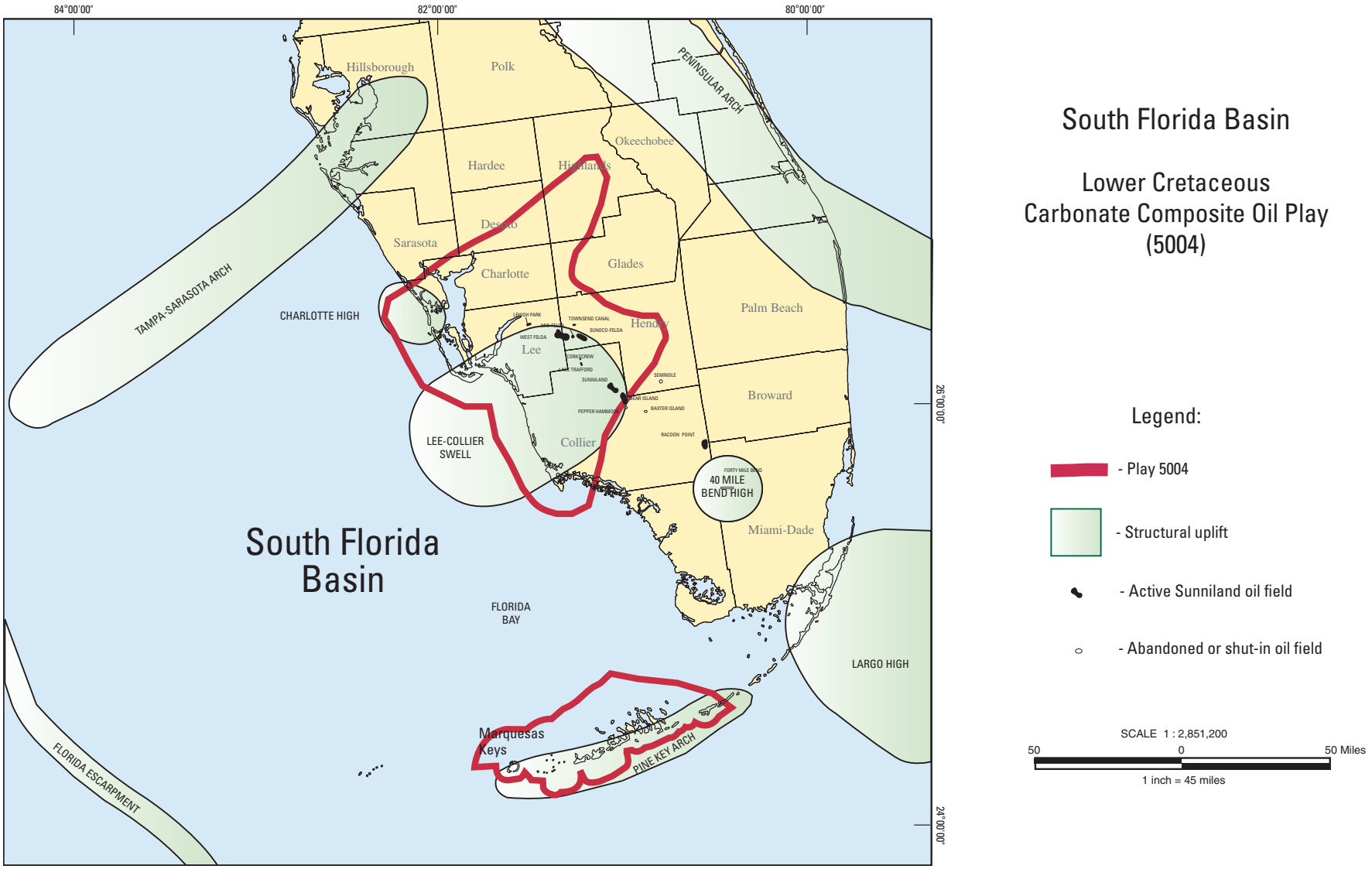

Figure 8. Map of South Florida Basin showing structural uplifts, known Sunniland oil fields, and boundaries of Lower Cretaceous Carbonate Composite Oil play (5004).

waters (Faulkner and Applegate, 1986). Projections indicate that the formation is as much as 1,500 ft thick in this area and that the best reservoirs exist within a thick porous dolomite zone (300–350 ft thick; pinpoint to vuggy porosity as high as 25 percent) in the middle and upper parts of the formation; depths range from about 12,500 ft to more than 15,000 ft.

Source-rock studies by Palacas and others (1981) indicate that organic-rich beds in the upper Pumpkin Bay Formation are likely source rocks for oils. These oils could be trapped in reservoirs that exist within the middle and upper parts of the Pumpkin Bay and in the porous brown dolomite zone. Palacas and others (1981) identified organic-rich, argillaceous carbonate beds with high (0.43–3.2 weight percent) TOC in the upper Pumpkin Bay and concluded that these beds had the greatest petroleum-generating potential of all rocks older than the Punta Gorda Anhydrite.

The TOC contents of these rocks, however, vary within the basin. Most rocks within the Twelve Mile Member of the Lehigh Acres Formation contain insufficient organic matter (average of about 0.3 percent TOC) to have generated commercial amounts of petroleum. Some richer source beds are present within this unit, however, having marginal (about 0.5 percent TOC) to good source potential. Particularly, more than 2.0 percent TOC is contained in a relatively thin (about 1 ft thick) limestone bed in the West Felda field.

The thermal-maturation level for oil generation is higher in this play than that for the upper and lower Sunniland plays (5001 and 5002). Thus, oils of this play are expected to be marginally to moderately mature and to have higher API gravities (25° to 50°) and higher GOR's than Sunniland oils.

Total mean volume of undiscovered oil in the Lower Cretaceous Carbonate Composite Oil play was estimated at about 11 MMBO. The median number of new discoveries is eight accumulations having a median field size of 2 MMBO (table 1).

Play 5005—Extended Upper Sunniland Tidal Shoal Oil Play

This hypothetical play is an eastward and southward extension (fig. 9) of the productive Sunniland trend in the Upper Sunniland Tidal Shoal Oil play (5001). Thus, reservoir and source rocks are the same as those of play 5001. This play forms a southwest-to-northeast-oriented arcuate trend approximately 20 mi wide and 250 mi long that extends from the State waters of the Dry Tortugas northeast, through the Florida Keys and along the southeastern Atlantic Coast of the Florida Peninsula to Broward County. Bioclastic mounds smaller than those found in currently productive units of the upper part of the Sunniland Formation accumulated on subtle structural highs in this updip, less thermally mature area of the basin to the east and far south. Prominent positive structural elements include the Pine Key arch and the Largo high. Some low API gravity (10°–14°) heavy-oil shows have been reported in wells in the northern portion of the play area; however, 22° API gravity oil was reported in shows from wells near the Marquesas Keys in the west and southernmost part of the play area (Faulkner and Applegate, 1986; Lloyd, 1992).

The Extended Upper Sunniland Tidal Shoal Oil play (5005) is delineated by an area that may contain porous tidal-shoal facies that formed on topographic/bathymetric highs. The dark carbonate source unit in the lower part of the Sunniland Formation thins toward the eastern and southern margins of the basin south of the play, making it less favorable than the proven Upper Sunniland Tidal Shoal Oil play (5001). The Sunniland Formation rocks in this area are also less thermally mature than in play 5001. The eastern and southern Atlantic coastal boundaries of the play are delineated by the Florida State waters 3-mi boundary, and the northern, Gulf of Mexico boundary is delineated by the 10.36 mi Florida State waters boundary.

Total mean volume of undiscovered oil in the Extended Upper Sunniland Tidal Shoal Oil play was estimated at about 27.3 MMBO with an additional 14.6 BCF of associated gas. The median number of new discoveries is six accumulations having a median field size of 4 MMBO (table 1).

Play 5006—Wood River Dolomite Deep Gas Play

In the hypothetical Wood River Dolomite Deep Gas play (fig. 2 and fig. 10), the Upper Jurassic(?) and Lower Cretaceous Wood River Formation averages about 1,700 ft thick and stratigraphically is the lowest sedimentary unit in the South Florida Basin. The few wells that have penetrated this formation show that a 100- to 150-ft-thick clastic unit forms the basal part of the Wood River Formation and consists of dark-red shale and fine- to coarse-grained arkosic sandstone and calcareous sandstone (Applegate and others, 1981). These basal clastic units may represent fan, fan-delta, and fluvial-lacustrine or marine deposits. Below the basal clastic sequence in Collier County is a rhyolite porphyry with an age of 189 Ma. Overlying these clastic rocks is a thick sequence of anhydrite, dolomite, and limestone with occasional interbedded salt stringers, indicating marine transgression (Applegate and others, 1981).

The Mobil-Phillips Seminole "C" well near Seminole field (fig. 10) in Hendry County produced measurable gas and water flows at depths of about 15,700 ft from perforations in a dolomite zone averaging about 8 percent porosity. Moreover, logs from the well indicated higher porosities and increased resistivities just above the perforated section, possibly indicating the presence of gas (Applegate and others, 1981; Palacas and others, 1981). Although formation damage occurred in the well bore, this well had potential for commercial gas production (J.G. Palacas, oral commun., 1994); the occurrence of a potentially commercial well indicates a possible source of deep gas. Marine beds, generally regarded as potential petroleum sources, are predominant in the formation, and the

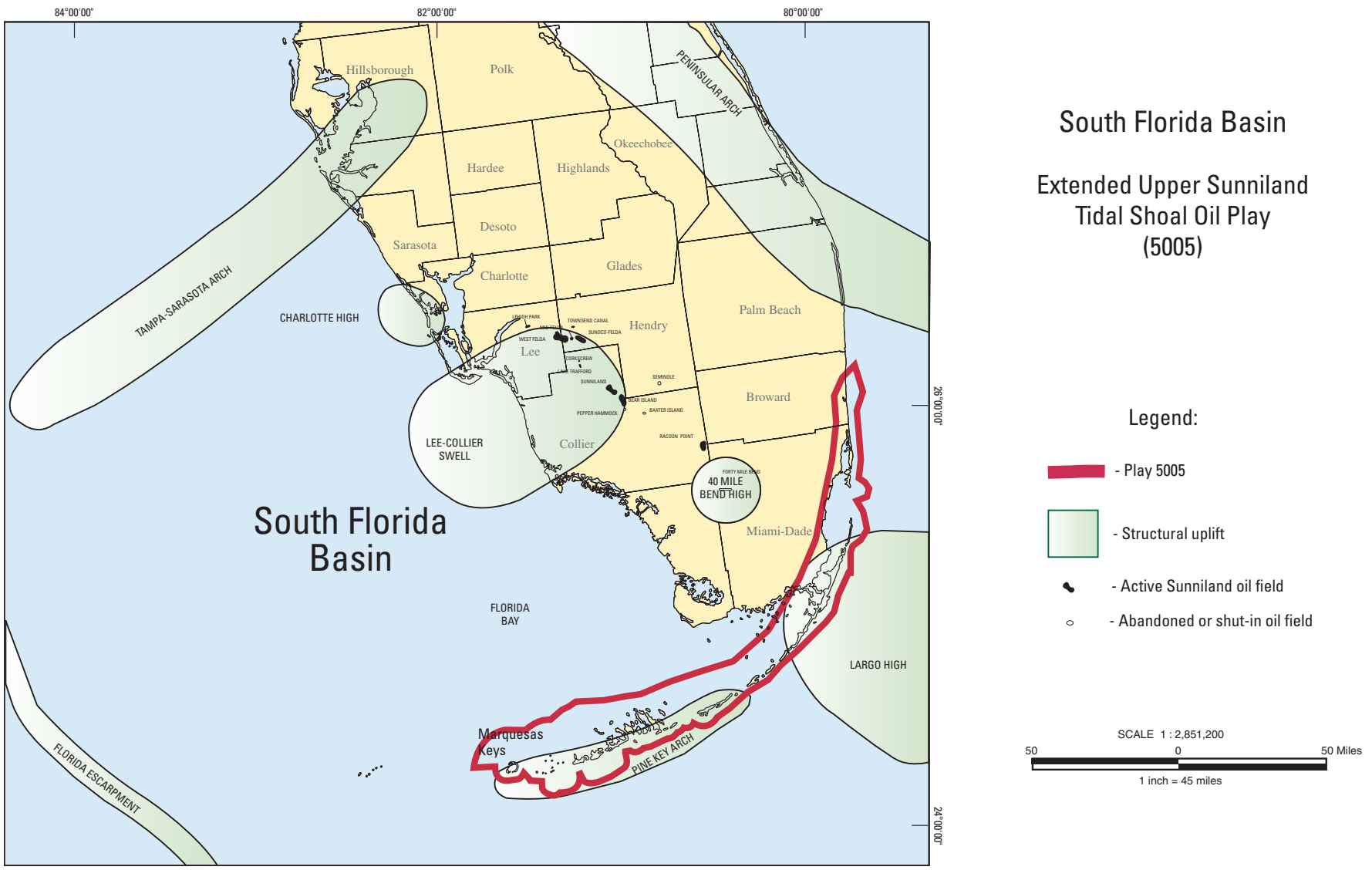

Figure 9. Map of South Florida Basin showing structural uplifts, known Sunniland oil fields, and boundaries of Extended Upper Sunniland Tidal Shoal Oil play (5005).

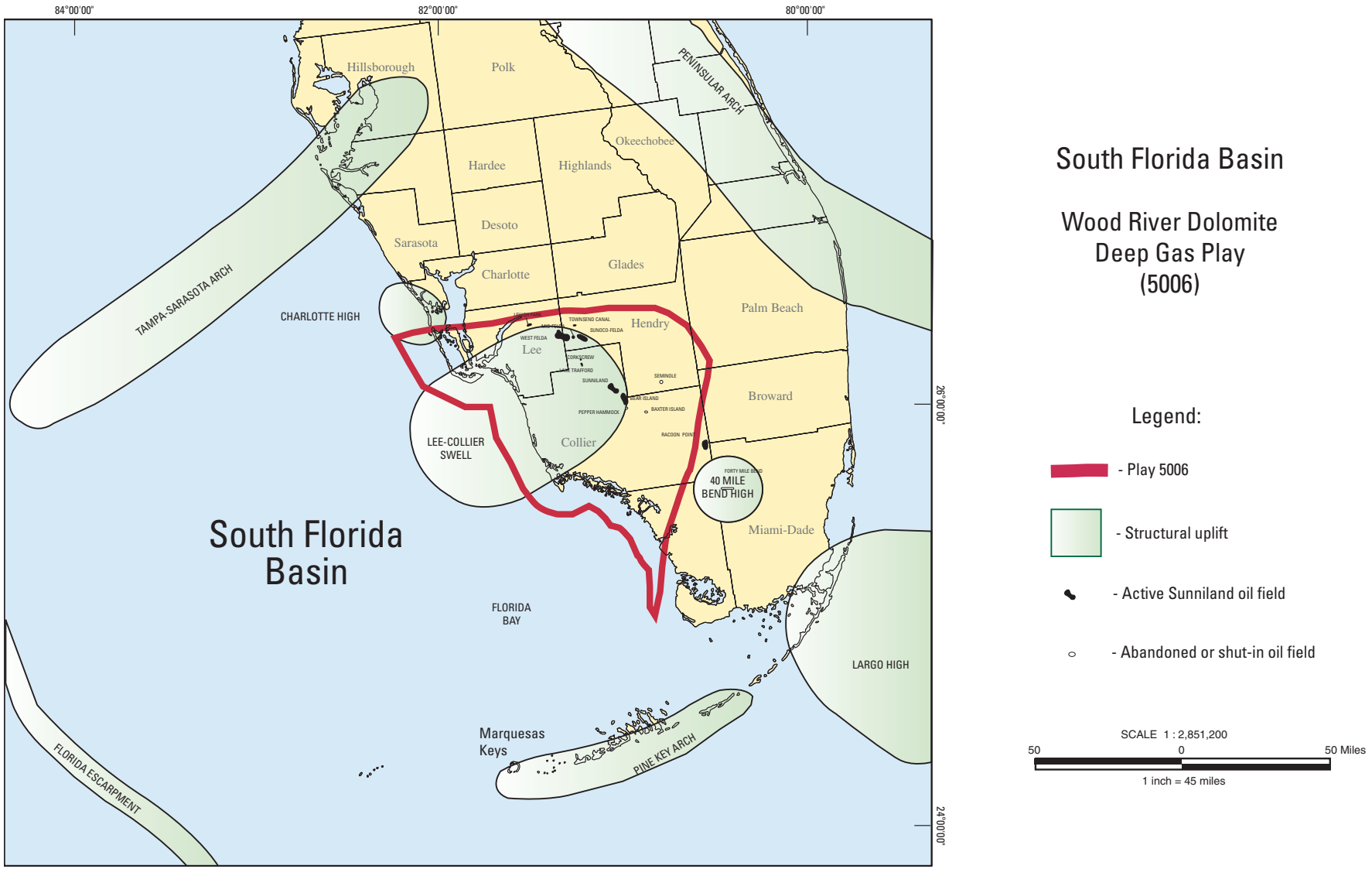

Figure 10. Map of South Florida Basin showing structural uplifts, known Sunniland oil fields, and boundaries of Wood River Dolomite Deep Gas play (5006).

depositional environment, especially in the southern part of the play area, probably favored reef growth; thus a source, a seal, and a reservoir should be present.

Organic geochemistry studies of well samples from the Wood River Formation indicate that the hydrocarbon-generating potential of the unit ranges from poor to excellent (Palacas and others, 1981; Faulkner and Applegate, 1986). The scarcity of wells penetrating the Wood River Formation, however, limits and evaluation of each of the geologic and petroleum system components of the play and, therefore, the play is considered hypothetical and was risked heavily. The rocks of potential reservoirs in the Wood River are porous (8 percent or greater) dolomite units enclosed by anhydrite, salt stringers, and (or) micritic limestone at depths of about 15,000–19,000 ft onshore and in State waters. The play area includes areas of the southern part of basin where reef growth is favored (fig. 10). It is possible that gas in the Wood River Formation in the area of the Sunniland trend may have originated in deeper parts of the basin and migrated updip, perhaps as a single large accumulation. The Wood River Dolomite Gas play was risked for charge, reservoir, and trap. The combined risk probability of the play was 0.1, which categorized the play as high risk and was not assessed in the 1995 USGS Assessment.

Summary

The 1995 USGS National Oil and Gas Assessment defined six conventional plays in the Florida Peninsula Province (USGS Province 50), all within the South Florida Basin. Five of these plays were assessed, all which were oil plays of Cretaceous age. The sixth was a deep gas play in dolomite of the Upper Jurassic(?) and Lower Cretaceous Wood River Formation and was highly risked, thus not assessed.

A mean total undiscovered resource of 370.1 MMBO and 57.5 BCFG (about 6 MMBOE) was estimated from the five oil plays of the South Florida Basin. The upper Sunniland Formation along the main "fairway" where eight fields of >1 MMBO have been discovered was estimated to contain the most (254 MMBO or about 70 percent) of the total estimated mean undiscovered oil in the South Florida Basin. The less mature, Dollar Bay Shoal-Reef play ranked second with a total estimated 66 MMBO. The future of Florida's moderate potential for undiscovered resources may be limited by environmental and political controls that discourage oil and gas exploration and development within the South Florida Basin.

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